

SCIENCE

NEW YORK, OCTOBER 16, 1891.

CELESTIAL PHYSICS.¹

I DO not purpose to attempt a survey of the progress of spectroscopic astronomy from its birth at Heidelberg in 1859, but to point out what we do know at present, as distinguished from what we do not know, of a few only of its more important problems, giving a prominent place, in accordance with the traditions of this chair, to the work of the last year or two.

In the spectroscope itself advances have been made by Lord Rayleigh by his discussion of the theory of the instrument, and by Professor Rowland in the construction of concave gratings.

Lord Rayleigh has shown that there is not the necessary connection, sometimes supposed, between dispersion and resolving power, as, besides the prism or grating, other details of construction and of adjustment of a spectroscope must be taken into account.

The resolving power of the prismatic spectroscope is proportional to the length of path in the dispersive medium. For the heavy flint glass used in Lord Rayleigh's experiments, the thickness necessary to resolve the sodium lines came out 1.02 centimetres. If this be taken as a unit, the resolving power of a prism of similar glass will be in the neighborhood of the sodium lines equal to the number of centimetres of its thickness. In other parts of the spectrum the resolving power will vary inversely as the third power of the wave-length, so that it will be eight times as great in the violet as in the red. The resolving power of a spectroscope is therefore proportional to the total thickness of the dispersive material in use, irrespective of the number, the angles, or the setting of the separate prisms into which, for the sake of convenience, it may be distributed.

The resolving power of a grating depends upon the total number of lines on its surface and the order of spectrum in use, about 1,000 lines being necessary to resolve the sodium lines in the first spectrum.

As it is often of importance in the record of observations to state the efficiency of the spectroscope with which they were made, Professor Schuster has proposed the use of a unit of purity as well as of resolving power, for the full resolving power of a spectroscope is realized in practice only when a sufficiently narrow slit is used. The unit of purity also is to stand for the separation of two lines differing by one-thousandth of their own wave-length, about the separation of the sodium pair at D.

A further limitation may come in from the physiological fact that, as Lord Rayleigh has pointed out, the eye, when its full aperture is used, is not a perfect instrument. If we wish to realize the full resolving power of a spectroscope, therefore, the emergent beam must not be larger than about one-third the opening of the pupil.

Up to the present time the standard of reference for nearly all spectroscopic work continues to be Angstrom's map of

the solar spectrum, and his scale based upon his original determinations of absolute wave-length. It is well known, as was pointed out by Thalén in his work on the spectrum of iron, in 1884, that Angstrom's figures are slightly too small, in consequence of an error existing in a standard metre used by him. The corrections for this have been introduced into the tables of the wave-lengths of terrestrial spectra collected and revised by a committee of this association from 1885 to 1887. Last year the committee added a table of corrections to Rowland's scale.

The inconvenience caused by a change of standard scale is, for a time at least, considerable; but there is little doubt that in the near future Rowland's photographic map of the solar spectrum, and his scale based on the determinations of absolute wave-length by Pierce and Bell, or the Potsdam scale based on original determinations by Müller and Kempf, which differs very slightly from it, will come to be exclusively adopted.

The great accuracy of Rowland's photographic map is due chiefly to the introduction by him of concave gratings, and of a method for their use by which the problem of the determination of relative wave-lengths is simplified to measures of coincidences of the lines in different spectra by a micrometer.

The concave grating and its peculiar mounting, in which no lenses or telescope are needed, and in which all the spectra are in focus together, formed a new departure of great importance in the measurement of spectral lines. The valuable method of photographic sensitizers for different parts of the spectrum has enabled Professor Rowland to include in his map the whole visible solar spectrum, as well as the ultra-violet portion as far as it can get through our atmosphere. Some recent photographs of the solar spectrum, which include A, by Mr. George Higgs, are of great technical beauty.

During the past year the results of three independent researches have appeared, in which the special object of the observers has been to distinguish the lines which are due to our atmosphere from those which are truly solar—the maps of M. Thollon, which, owing to his lamented death just before their final completion, have assumed the character of a memorial of him; maps by Dr. Becker; and sets of photographs of a high and a low sun by Mr. McClean.

At the meeting of this association in Bath, M. Janssen gave an account of his own researches on the terrestrial lines of the solar spectrum which owe their origin to the oxygen of our atmosphere. He discovered the remarkable fact that, while one class of bands varies as the density of the gas, other diffuse bands vary as the square of the density. These observations are in accordance with the work of Egoroff and of Olszewski, and of Liveing and Dewar on condensed oxygen. In some recent experiments Olszewski, with a layer of liquid oxygen thirty millimetres thick, saw, as well as four other bands, the band coincident with Fraunhofer's A, a remarkable instance of the persistence of absorption through a great range of temperature. The light which passed through the liquid oxygen had a light blue color resembling that of the sky.

¹ Inaugural address at the meeting of the British Association for the Advancement of Science, at Cardiff, August, 1891, by William Huggins, president of the association (*Nature*, Aug. 20).

Of not less interest are the experiments of Knut Angstrom, which show that the carbonic acid and aqueous vapor of the atmosphere reveal their presence by dark bands in the invisible infra-red region, at the positions of bands of emission of these substances.

It is now some thirty years since the spectroscope gave us for the first time certain knowledge of the nature of the heavenly bodies, and revealed the fundamental fact that terrestrial matter is not peculiar to the solar system, but is common to all the stars which are visible to us.

In the case of a star such as Capella, which has a spectrum almost identical with that of the sun, we feel justified in concluding that the matter of which it is built up is similar, and that its temperature is also high, and not very different from the solar temperature. The task of analyzing the stars and nebulae becomes, however, one of very great difficulty when we have to do with spectra differing from the solar type. We are thrown back upon the laboratory for the information necessary to enable us to interpret the indications of the spectroscope as to the chemical nature, the density and pressure, and the temperature of the celestial masses.

What the spectroscope immediately reveals to us are the waves which were set up in the ether filling all interstellar space, years or hundreds of years ago, by the motions of the molecules of the celestial substances. As a rule, it is only when a body is gaseous and sufficiently hot that the motions within its molecules can produce bright lines and a corresponding absorption. The spectra of the heavenly bodies are, indeed, to a great extent absorption spectra, but we have usually to study them through the corresponding emission spectra of bodies brought into the gaseous form and rendered luminous by means of flames or of electric discharges. In both cases, unfortunately, as has been shown recently by Professors Liveing and Dewar, Wüllner, E. Wiedemann, and others, there appears to be no certain direct relation between the luminous radiation as shown in the spectroscope and the temperature of the flame, or of the gaseous contents of the vacuum tube—that is, in the usual sense of the term as applied to the mean motion of all the molecules. In both cases the vibratory motions within the molecules to which their luminosity is due are almost always much greater than would be produced by encounters of molecules having motions of translation no greater than the average motions which characterize the temperature of the gases as a whole. The temperature of a vacuum tube through which an electric discharge is taking place may be low, as shown by a thermometer, quite apart from the consideration of the extreme smallness of the mass of gas, but the vibrations of the luminous molecules must be violent in whatever way we suppose them to be set up by the discharge: if we take Schuster's view that comparatively few molecules are carrying the discharge, and that it is to the fierce encounters of these alone that the luminosity is due, then if all the molecules had similar motions, the temperature of the gas would be very high.

So in flames where chemical changes are in progress, the vibratory motions of the molecules which are luminous may be, in connection with the energy set free in these changes, very different from those corresponding to the mean temperature of the flame.

Under the ordinary conditions of terrestrial experiments, therefore, the temperature or the mean *vis viva* of the molecules may have no direct relation to the total radiation, which, on the other hand, is the sum of the radiation due to each luminous molecule.

These phenomena have recently been discussed by Ebert from the standpoint of the electro-magnetic theory of light.

Very great caution is therefore called for when we attempt to reason by the aid of laboratory experiments to the temperature of the heavenly bodies from their radiation, especially on the reasonable assumption that in them the luminosity is not ordinarily associated with chemical changes or with electrical discharges, but is due to a simple glowing from the ultimate conversion into molecular motion of the gravitational energy of shrinkage.

In a recent paper, Stas maintains that electric spectra are to be regarded as distinct from flame spectra, and, from researches of his own, that the pairs of lines of the sodium spectrum other than D are produced only by disruptive electric discharges. As these pairs of lines are found reversed in the solar spectrum, he concludes that the sun's radiation is due mainly to electric discharges. But Wolf and Diacon, and later, Watts, observed the other pairs of lines of the sodium spectrum when the vapor was raised above the ordinary temperature of the Bunsen flame. Recently, Liveing and Dewar saw easily, besides D, the citron and green pairs, and sometimes the blue pair and the orange pair, when hydrogen charged with sodium vapor was burning at different pressures in oxygen. In the case of sodium vapor, therefore, and presumably in all other vapors and gases, it is a matter of indifference whether the necessary vibratory motion of the molecules is produced by electric discharges or by flames. The presence of lines in the solar spectrum which we can only produce electrically is an indication, however, as Stas points out, of the high temperature of the sun.

We must not forget that the light from the heavenly bodies may consist of the combined radiations of different layers of gas at different temperatures, and possibly be further complicated to an unknown extent by the absorption of cooler portions of gas outside.

Not less caution is needed if we endeavor to argue from the broadening of lines and the coming in of a continuous spectrum as to the relative pressure of the gas in the celestial atmospheres. On the one hand, it cannot be gainsaid that in the laboratory the widening of the lines in a Plücker's tube follows upon increasing the density of the residue of hydrogen in the tube, when the vibrations are more frequently disturbed by fresh encounters, and that a broadening of the sodium lines in a flame at ordinary pressure is produced by an increase of the quantity of sodium in the flame; but it is doubtful if pressure, as distinguished from quantity, does produce an increase of the breadth of the lines. An individual molecule of sodium will be sensibly in the same condition, considering the relatively enormous number of the molecules of the other gases, whether the flame is scantily or copiously fed with the sodium salt. With a small quantity of sodium vapor the intensity will be feeble except near the maximum of the lines; when, however, the quantity is increased, the comparative transparency on the sides of the maximum will allow the light from the additional molecules met with in the path of the visual ray to strengthen the radiation of the molecules farther back, and so increase the breadth of the lines.

In a gaseous mixture it is found, as a rule, that at the same pressure or temperature, as the encounters with similar molecules become fewer, the spectral lines will be affected as if the body were observed under conditions of reduced quantity or temperature.

In their recent investigation of the spectroscopic behavior

of flames under various pressures up to forty atmospheres, Professors Liveing and Dewar have come to the conclusion that, though the prominent feature of the light emitted by flames at high pressure appears to be a strong continuous spectrum, there is not the slightest indication that this continuous spectrum is produced by the broadening of the lines of the same gases at low pressure. On the contrary, photometric observations of the brightness of the continuous spectrum, as the pressure is varied, show that it is mainly produced by the mutual action of the molecules of a gas. Experiments on the sodium spectrum were carried up to a pressure of forty atmospheres without producing any definite effect on the width of the lines which could be ascribed to the pressure. In a similar way the lines of the spectrum of water showed no signs of expansion up to twelve atmospheres; though more intense than at ordinary pressure, they remained narrow and clearly defined.

It follows, therefore, that a continuous spectrum cannot be considered, when taken alone, as a sure indication of matter in the liquid or the solid state. Not only, as in the experiments already mentioned, such a spectrum may be due to gas when under pressure, but, as Maxwell pointed out, if the thickness of a medium, such as sodium vapor, which radiates and absorbs different kinds of light, be very great, and the temperature high, the light emitted will be of exactly the same composition as that emitted by lamp-black at the same temperature, for the radiations which are feebly emitted will be also feebly absorbed, and can reach the surface from immense depths. Shuster has shown that oxygen, even in a partially exhausted tube, can give a continuous spectrum when excited by a feeble electric discharge.

Compound bodies are usually distinguished by a banded spectrum; but, on the other hand, such a spectrum does not necessarily show the presence of compounds,—that is, of molecules containing different kinds of atoms,—but simply of a more complex molecule, which may be made up of similar atoms, and be, therefore, an allotropic condition of the same body. In some cases—for example, in the diffuse bands of the absorption spectrum of oxygen—the bands may have an intensity proportional to the square of the density of the gas, and may be due either to the formation of more complex molecules of the gas with increase of pressure, or it may be to the constraint to which the molecules are subject during their encounter with one another.

It may be thought that at least in the coincidences of bright lines we are on the solid ground of certainty, since the length of the waves set up in the ether by a molecule, say of hydrogen, is the most fixed and absolutely permanent quantity in nature, and is so of physical necessity, for with any alteration the molecule would cease to be hydrogen.

Such would be the case if the coincidence were certain; but an absolute coincidence can only be a matter of greater or less probability, depending on the resolving power employed, on the number of the lines which correspond, and on their characters. When the coincidences are very numerous, as in the case of iron and the solar spectrum, or the lines are characteristically grouped, as in the case of hydrogen and the solar spectrum, we may regard the coincidence as certain; but the progress of science has been greatly retarded by resting important conclusions upon the apparent coincidence of single lines in spectroscopes of very small resolving power. In such cases, unless other reasons supporting the coincidence are present, the probability of a real coincidence is almost too small to be of any importance, especially in the

case of a heavenly body which may have a motion of approach or of recession of unknown amount.

But even here we are met by the confusion introduced by multiple spectra, corresponding to different molecular groupings of the same substance; and, further, to the influence of substances in vapor upon each other; for when several gases are present together, the phenomena of radiation and reversal by absorption are by no means the same as if the gases were free from each other's influence, and especially is this the case when they are illuminated by an electric discharge.

I have said as much as time will permit, and I think indeed sufficient, to show that it is only by the laborious and slow process of most cautious observation that the foundations of the science of celestial physics can be surely laid. We are at present in a time of transition, when the earlier, and, in the nature of things, less precise, observations are giving place to work of an order of accuracy much greater than was formerly considered attainable with objects of such small brightness as the stars.

The accuracy of the earlier determinations of the spectra of the terrestrial elements are in most cases insufficient for modern work on the stars as well as on the sun. They fall much below the scale adopted in Rowland's map of the sun, as well as below the degree of accuracy attained at Potsdam by photography in a part of the spectrum for the brighter stars. Increase of resolving power very frequently breaks up into groups, in the spectra of the sun and stars, the lines which had been regarded as single, and their supposed coincidences with terrestrial lines fall to the ground. For this reason many of the early conclusions, based on observation as good as it was possible to make at the time with the less powerful spectroscopes then in use, may not be found to be maintained under the much greater resolving power of modern instruments.

The spectroscope has failed as yet to interpret for us the remarkable spectrum of the Aurora Borealis. Undoubtedly in this phenomenon portions of our atmosphere are lighted up by electric discharges: we should expect, therefore, to recognize the spectra of the gases known to be present in it. As yet we have not been able to obtain similar spectra from these gases artificially, and especially we do not know the origin of the principal line in the green, which often appears alone, and may have, therefore, an origin independent of that of the other lines. Recently the suggestion has been made that the aurora is a phenomenon produced by the dust of meteors and falling stars, and that near positions of certain auroral lines or flutings of manganese, lead, barium, thallium, iron, etc., are sufficient to justify us in regarding meteoric dust in the atmosphere as the origin of the auroral spectrum. Liveing and Dewar have made a conclusive research on this point, by availing themselves of the dust of excessive minuteness thrown off from the surface of electrodes of various metals and meteorites by a disruptive discharge, and carried forward into the tube of observation by a more or less rapid current of air or other gas. These experiments prove that metallic dust, however fine, suspended in a gas will not act like gaseous matter in becoming luminous with its characteristic spectrum in an electric discharge similar to that of the aurora. Professor Schuster has suggested that the principal line may be due to some very light gas which is present in too small a proportion to be detected by chemical analysis or even by the spectroscope in the presence of the other gases near the earth, but which at the height of the auroral discharges is in a sufficiently greater relative

proportion to give a spectrum. Lemström, indeed, states that he saw this line in the silent discharge of a Holtz machine on a mountain in Lapland. The lines may not have been obtained in our laboratories from the atmospheric gases on account of the difficulty of reproducing in tubes with sufficient nearness the conditions under which the auroral discharges take place.

In the spectra of comets the spectroscope has shown the presence of carbon presumably in combination with hydrogen, and also sometimes with nitrogen; and in the case of comets approaching very near the sun, the lines of sodium, and other lines which have been supposed to belong to iron. Though the researches of Professor H. A. Newton and of Professor Schiaparelli leave no doubt of the close connection of comets with corresponding periodic meteor-swarms, and therefore of the probable identity of cometary matter with that of meteorites, with which the spectroscopic evidence agrees, it would be perhaps unwise at present to attempt to define too precisely the exact condition of the matter which forms the nucleus of the comet. In any case the part of the light of the comet which is not reflected solar light can scarcely be attributed to a high temperature produced by the clashing of separate meteoric stones set up within the nucleus by the sun's disturbing force. We must look rather to disruptive electric discharges, produced probably by processes of evaporation due to increased solar heat, which would be amply sufficient to set free portions of the occluded gases into the vacuum of space. May it be that these discharges are assisted, and indeed possibly increased, by the recently discovered action of the ultra-violet part of the sun's light? Lenard and Wolfe have shown that ultra-violet light can produce a discharge from a negatively electrified piece of metal, while Hallwachs and Righi have shown further that ultra-violet light can even charge positively an unelectrified piece of metal. Similar actions on cometary matter, unscreened as it is by an absorptive atmosphere, at least of any noticeable extent, may well be powerful when a comet approaches the sun, and help to explain an electrified condition of the evaporated matter which would possibly bring it under the sun's repulsive action. We shall have to return to this point in speaking of the solar corona.

A very great advance has been made in our knowledge of the constitution of the sun by the recent work at the Johns Hopkins University by means of photography and concave gratings, in comparing the solar spectrum, under great resolving power, directly with the spectra of the terrestrial elements. Professor Rowland has shown that the lines of thirty-six terrestrial elements at least are certainly present in the solar spectrum, while eight others are doubtful. Fifteen elements, including nitrogen as it shows itself under an electric discharge in a vacuum tube, have not been found in the solar spectrum. Some ten other elements, inclusive of oxygen, have not yet been compared with the sun's spectrum.

Rowland remarks that of the fifteen elements named as not found in the sun, many are so classed because they have few strong lines, or none at all, in the limit of the solar spectrum as compared by him with the arc. Boron has only two strong lines. The lines of bismuth are compound and too diffuse. Therefore even in the case of these fifteen elements there is little evidence that they are really absent from the sun.

It follows that if the whole earth were heated to the temperature of the sun, its spectrum would resemble very closely the solar spectrum.

Rowland has not found any lines common to several elements, and in the case of some accidental coincidences, more accurate investigation reveals some slight difference of wavelength or a common impurity. Further, the relative strength of the lines in the solar spectrum is generally, with a few exceptions, the same as that in the electric arc, so that Rowland considers that his experiments show "very little evidence" of the breaking up of the terrestrial elements in the sun.

Stas, in a recent paper, gives the final results of eleven years of research on the chemical elements in a state of purity, and on the possibility of decomposing them by the physical and chemical forces at our disposal. His experiments on calcium, strontium, lithium, magnesium, silver, sodium, and thallium show that these substances retain their individuality under all conditions, and are unalterable by any forces that we can bring to bear upon them.

Professor Rowland looks to the solar lines which are unaccounted for as a means of enabling him to discover such new terrestrial elements as still lurk in rare minerals and earths, by confronting their spectra directly with that of the sun. He has already resolved yttrium spectroscopically into three components, and actually into two. The comparison of the results of this independent analytical method with the remarkable but different conclusions to which M. Lecoq de Boisbaudran and Mr. Crookes have been led respectively, from spectroscopic observation of these bodies when glowing under molecular bombardment in a vacuum tube, will be awaited with much interest. It is worthy of remark that, as our knowledge of the spectrum of hydrogen in its complete form came to us from the stars, it is now from the sun that chemistry is probably about to be enriched by the discovery of new elements.

In a discussion of the Bakerian lecture for 1885 of what we knew up to that time of the sun's corona, I was led to the conclusion that the corona is essentially a phenomenon similar in the cause of its formation to the tails of comets — namely, that it consists for the most part probably of matter going from the sun under the action of a force, possibly electrical, which varies as the surface, and can therefore in the case of highly attenuated matter easily master the force of gravity even near the sun. Though many of the coronal particles may return to the sun, those which form the long rays or streamers do not return; they separate and soon become too diffused to be any longer visible, and may well go to furnish the matter of the zodiacal light, which otherwise has not received a satisfactory explanation. And further, if such a force exist at the sun, the changes of terrestrial magnetism may be due to direct electric action as the earth moves through lines of inductive force.

These conclusions appear to be in accordance broadly with the lines along which thought has been directed by the results of subsequent eclipses. Professor Schuster takes an essentially similar view, and suggests that there may be a direct electric connection between the sun and the planets. He asks further whether the sun may not act like a magnet in consequence of its revolution about its axis. Professor Bigelow has recently treated the coronal forms by the theory of spherical harmonics, on the supposition that we see phenomena similar to those of free electricity, the rays being lines of force, and the coronal matter discharged from the sun, or at least arranged or controlled by these forces. At the extremities of the streams for some reason the repulsive power may be lost, and gravitation set in, bringing the matter back to the sun. The matter which does leave the sun is

persistently transported to the equatorial plane of the corona; in fact, the zodiacal light may be the accumulation at great distances from the sun along this equator of such like material. Photographs on a larger scale will be desirable for the full development of the conclusions which may follow from this study of the curved forms of the coronal structure. Professor Schaeberle, however, considers that the coronal phenomena may be satisfactorily accounted for on the supposition that the corona is formed of streams of matter ejected mainly from the spot zones with great initial velocities, but smaller than 382 miles per second; further, that the different types of the corona are due to the effects of perspective on the streams from the earth's place at the time relatively to the plane of the solar equator.

Of the physical and the chemical nature of the coronal matter we know very little. Schuster concludes, from an examination of the eclipses of 1882, 1883, and 1886, that the continuous spectrum of the corona has the maximum of actinic intensity displaced considerably towards the red when compared with the spectrum of the sun, which shows that it can only be due in small part to solar light scattered by small particles. The lines of calcium and of hydrogen do not appear to form part of the normal spectrum of the corona. The green coronal line has no known representative in terrestrial substances, nor has Schuster been able to recognize any of our elements in the other lines of the corona.

(To be continued.)

NOTES AND NEWS.

RECENT additions to the stock of Geo. L. English & Co., the well-known mineralogists, have been so extensive that they have been compelled to issue a supplement to their "Catalogue of Minerals." "Supplement A" contains 20 pages well filled with descriptions of new specimens procured in different parts of the world by the three collectors who have been at work during the summer.

—"As I went to the train one morning," writes a correspondent of *Nature*, "I saw a brown retriever dog coming full speed with a letter in his mouth. He went straight to the mural letter box. The postman had just cleared the box, and was about twenty or thirty yards off when the dog arrived. Seeing him, the sagacious animal went after him, and had the letter transferred to the bag. He then walked home quietly."

—Dr. Loewenberg of Paris discusses the influence of sex in what he calls the "lateralization" of ear disease. After referring to the view generally held by otologists that the left ear is more liable to be attacked alone, or to be attacked first and to suffer more severely when both ears are affected, he says, according to the *British Medical Journal*, that he has for a long time past been struck with the fact that, while deafness is more common on the left side in men, the same does not hold good in the case of women. From statistics of 3,000 cases (not including diseases of the concha and external meatus) which have come under his own notice, he shows, in the first place, that the male sex is more subject to ear disease than the female, there having been 1,790 of the former to 1,210 of the latter. Among those in whom only one ear was affected there were 478 men and 311 women. The right ear alone was affected in 212 men and 167 women; the left alone in 266 men and 144 women. Deafness existed in both ears in 1,074 men and 737 women. Among this number the right ear was the more deaf of the two in 427 men and 340 women, the left in 647 men and 397 women. Deafness was equal on both sides in 238 men and 162 women.

—The Ohio State University opened the fall term on Sept. 16, with a more than usual increase of attendance. In the agricultural and veterinary departments the number is over thirty per cent larger than last year, and the increase of the various departments together is much larger than any previous year. This is

probably due to the passage of the Hysell bill last year, which brought the institution before the minds of the people, and also put it beyond financial embarrassment. In addition to the nine buildings now in use, the ground will be broken this fall for two more large buildings,—one for the manual training school and the other for the museum and library. Several full professors have been added to the faculty, besides a number of assistants. The School of Law, which is a new department, opened its first session on Oct. 1, at the Franklin County Court House in Columbus, where students will have unusual facilities for observing the organization and working of courts, the actual progress of trials, etc. The new school starts out in a way that promises prosperity. The biological club held its first meeting of the term on Sept. 22, when interesting reports of the summer's work were submitted by the members. Several new members were elected, among them W. A. Kellerman, professor of botany in the university, and Professor F. M. Webster, entomologist at the Experiment Station. Both are valuable acquisitions to the club, each having travelled and done biological work both at home and abroad.

—The monthly report of the State Geologist of Missouri states that during September detailed mapping has been continued in Henry and St. Francois counties, and, in the former, most excellent progress has been made. In all, some one hundred and fifteen square miles have been covered. The mapping of the crystalline rocks in the south-east, and of the other geological formations in Webster, Greene, and Christian Counties has been actively pushed, and nearly two hundred square miles have been completed during the month. Inspections of iron ore deposits have been made in Reynolds, Texas, Wright, Douglas, Christian, Taney, Greene, Lawrence, Franklin, Gasconade, Howell, Jasper, and Laclede Counties. The results of this work so far indicate that the extent of the limonite ores of the southern part of the State is much greater than has been anticipated, and that there is a promising outlook for the development of manganese ores in this region. Inspections of lead and zinc deposits have been made in Polk, Dade, Taney, Laclede, Phelps, Douglas, Marion, and Franklin Counties. The quaternary deposits have been studied in Cape Girardeau, St. Louis, Franklin, Marion, Pike, Lincoln, St. Charles, Livingston, Chariton, Daviess, and Buchanan Counties. Good progress has been made in the preparation of the report on the paleontology of the State. Some two hundred and forty pages of manuscript are already written, and arrangements are about completed for the engraving of the plates to accompany the volume. The preliminary reports on the coal deposits of the State is nearly completed, and much time has been spent during the past month on the preparation of the manuscript and illustrations for it, and the draughting of detailed maps and sections preparatory to engraving has continued uninterruptedly.

—Queen & Co., Philadelphia, will, in a short time, transfer their entire plant, now located at 924 Chestnut Street, to the larger building, 1010 Chestnut Street. The public of Philadelphia speak of Queen's as "opticians," and comparatively few outside of the professional world are aware of the magnitude of their business. A brief description of each department may be of interest. Department No. 1 is devoted to spectacles, eye-glasses, opera glasses, field and marine glasses, and apparatus for oculists, including ophthalmoscopes, trial glasses, perimeters, etc. Department No. 2 is devoted to instruments of precision required by engineers, architects, draughtsmen, students, and others. No. 3 is for microscopes and all instruments which are allied to the microscope. From this department comes the *Microscopical Bulletin*. No. 4 is one of the most extensive and interesting. Here are to be found the various apparatus required in the physical laboratories of schools and colleges. No. 5 is devoted to magic lanterns, or, in scientific terms, apparatus for luminous projection, views, and accessory apparatus. Spy-glasses, astronomical telescopes, and solar transits are also included. No. 6 includes meteorological instruments. This department recently supplied the United States War Department with the Boulange chronographs for determining the velocity of projectiles. No. 7 is the photographic department. Every effort will be made to have this department attractive in the new building. Dark rooms for developing, etc., will be provided, and com-

petent instructors will be on hand to show the would-be photographer "how to do it." This department gives especial attention to the photographing of buildings, country seats, vessels, machinery, and to the developing and printing of exposures made by amateurs and others. In addition to these departments, Queen & Co. operate three factories and a brass foundry. Their largest factory is devoted to the manufacture of the various instruments of precision. Another factory is for the manufacture of thermometers only. The optical factory is for the manufacture of spectacles, eye-glasses, lenses, etc. They employ in the neighborhood of two hundred hands in the various departments of their business.

— Three letters from Alexander Agassiz, published in the Bulletin of the Museum of Comparative Zoology, give some interesting particulars of the expedition of the "Albatross." The deep-sea fauna in the neighborhood of Panama is poor compared to that of the eastern shores of the continent. Probably this poverty is due to the absence of a great oceanic current, bringing supplies of food. West Indian forms preponderate. The southern slope of the Galapagos also did not yield the rich fauna that was expected, though it lies in the track of a great current from the south. A gigantic ostracod, more than an inch long, was dredged up between Cape San Francisco and the Galapagos and also in the Gulf of California.

— Mr. John Bogart, State Engineer of New York, has sent in a report concerning the recession of Niagara Falls. In 1842 Professor James Hall made an accurate survey, and a comparison of his results with those of 1890, made in a bulletin of the American Geographical Society, shows that the annual recession at the American Fall has been 7.68 inches, and at the Canadian, or Horseshoe Fall, 2 feet 2.16 inches. During this period the crest line of the American Fall has sunk from 1,080 to 1,060 feet, and that of the Canadian has risen from 2,260 to 3,010 feet. The area of rock which has been carried away during those forty-eight years is 32,900 square feet at the American Fall and 275,400 square feet at the Canadian Fall.

— Sparrows do not seem to lose in New Zealand any of the audacity for which they are famous in Europe, says *Nature*. In a paper read some time ago before the New Zealand Institute, and now printed in the *Transactions*, Mr. T. W. Kirk gives an example of what he calls their "daring and cool impudence." Between Featherston and Martinborough he heard one day a most unusual noise, as though all the small birds in the country had joined in one grand quarrel. Looking up, he saw a large hawk (*C. Gouldi*—a carrion-feeder) being buffeted by a flock of sparrows. They kept dashing at him in scores, and from all points at once. The unfortunate hawk was quite powerless; indeed, he seemed to have no heart left, for he did not attempt to retaliate, and his defence was of the feeblest. At last, approaching some scrub, he made a rush indicative of a forlorn hope, gained the shelter, and there remained. Mr. Kirk watched for fully half an hour, but he did not reappear. The sparrows congregated in groups about the bushes, keeping up a constant chattering and noise, evidently on the look-out for the enemy, and congratulating themselves upon having secured a victory.

— Some interesting observations relating to the surgical treatment of wounds by birds were recently brought by M. Fatio before the Physical Society of Geneva. According to the *Medical Record*, he quoted the case of the snipe, which he had often observed engaged in repairing damages. With its beak and feathers it makes a very creditable dressing, applying plasters to bleeding wounds, and even securing a broken limb by means of a stout ligature. On one occasion he killed a snipe which had on the chest a large dressing composed of down taken from other parts of the body and securely fixed to the wound by the coagulated blood. Twice he had brought home snipe with interwoven feathers strapped on to the site of fracture of one or other limb. The most interesting example was that of a snipe both of whose legs he had unfortunately broken by a misdirected shot. He recovered the animal only on the day following, and he then found that the poor bird had contrived to apply dressings and a sort of splint to both limbs. In carrying out this operation some feathers had become entangled

around the beak, and not being able to use its claws to get rid of them, it was almost dead from hunger when discovered. In a case recorded by M. Magnin, a snipe which was observed to fly away with a broken leg was subsequently found to have forced the fragments into a parallel position, the upper fragments reaching to the knee, and secured them there by means of a strong band of feathers and moss intermingled. The observers were particularly struck by the application of a ligature of a kind of flat-leaved grass wound round the limb, of a spiral form, and fixed by means of a sort of glue.

— There are three electrolytic processes now in commercial operation for the production of aluminum. These, as described in *Engineering*, are the Hall process, worked by the Pittsburg Reduction Company; the Heroult process, worked by the Aluminum Industrie Actien Gesellschaft, at Neuhausen, Switzerland, and by the Société Electro-Metallurgique de France at Froges; and the Minet process, used at the works of Bernard Brothers, at Creil, France. The two former processes, and the works where they are carried on, have been fully described within the last year. The last consists in electrolyzing a mixture of sodium chloride with aluminum fluoride, or with the double fluoride of sodium and aluminum, and is being carried out successfully. The metal ordinarily sold contains two to three per cent of impurities,—generally silicon and iron,—and is usually benefitted by the presence of the former, as it adds hardness and strength. Aluminum becomes pasty at about 1,000° F., and melts at 1,300°. It loses much of its tensile strength at 400° to 500° F., at which temperature it anneals. The coefficient of linear expansion under heat when of 98.5 per cent purity is .0000206 per degree Centigrade between the freezing and boiling points of water. This nearly corresponds with the expansion of tin, which is .0000217. The specific heat is .2143, and the thermal conductivity 73.6, silver being taken as 100. Recently a way of soldering aluminum has been discovered, with hard and soft solder, and with an alloy of zinc and aluminum. The nature of the soldering fluid has not yet been published. The shrinkage of aluminum in casting is $\frac{1}{6}$ of an inch per foot, or about 2.26 per cent of the length of the mould.

— MM. Rousson and Willems have completed the exploration of the northern extremity of the main island of Tierra del Fuego, and have communicated the results to the French Minister of Instruction (*Compte Rendu* of the Paris Geo. Soc., Nos. 7 and 8, 1891). The part referred to is bounded towards the south by a line drawn from Useless Bay to the Bay of San Sebastian. It is traversed by a chain of mountains, which rises suddenly at Cape Esquillon to a height of 1,600 feet, and terminates at Cape Espiritu Santo. The rest of the country, according to the *Scottish Geographical Magazine*, consists of great plains watered by numerous rivers, many of which dry up in summer. The most important is Rio del Oro, which flows into Philip Bay. Tierra del Fuego has a great variety of climates, but on the whole the cold is not as severe as might have been expected. The lowest temperature observed was 43° F., and the highest 69°. The nights are always cold. The barometer is subject to very sudden and considerable changes, and the winds are frequent and violent, those from the west often attaining a velocity of nearly a thousand feet per second. The Onas, who inhabit the northern part of the island, are very tall, sometimes six feet six inches, or more, in height. They are copper-colored, have oval faces and long hair plastered with clay, small eyes, prominent cheek bones, large mouths, and a few hairs on the chin. Their only clothing is a cape of guanaco or fox skin, and, sometimes, a triangular covering of leather on the head. The men occupy themselves solely in fighting with their neighbors and hunting, their chief weapons being bows and arrows tipped with pieces of glass, found on the shore, or flint. All the household labor falls on the women. Their encampments consist of circular holes, five feet in diameter and sixteen inches deep, dug out of the side of a mountain, with stakes set up round them to support a covering of skins. The Onas are not cannibals, as some travellers have asserted, nor do they burn their dead. The native population cannot be estimated at more than three hundred, but in summer the number of inhabitants is largely increased by miners, who return to Punta Arenas in winter. The

flora of the country is poor, no trees growing in the north of the island and but few shrubs. Quadrupeds are scarce, the principal being the guanaco, dog, fox, and one or two small rodents, but snipe, ducks, geese, owls, swans, and other birds are plentiful. Magnetic iron is widely distributed and in large quantities, and gold, mixed with very small garnets and rubies, is found in several places. There are also some coal seams of very poor quality, and abundance of clay suitable for the manufacture of earthenware. It is probable that the land will in time be taken up for grazing purposes. Within the last few years several small farms have been established and have yielded large returns. On Dawson Island the Jesuits have a model farm, where nearly 20,000 sheep and more than 6,000 cattle are fed.

— It is stated by *Engineering* that half the tin of the world is exported from the Malay Peninsula, where mining is carried on almost entirely by Chinese. The mining is that of flood tin, and the metal is taken from the lowlands near the mountains, where it is found in pockets ten to twenty feet or more below the surface.

— Mr. W. Mattiere Williams, in a letter to *Nature* of Oct. 1, writes as follows: "On two occasions, when proceeding northwards to Arctic Norway, I was much interested in observing the fact that the plague of mosquitoes, which is so intolerable there, especially prevails in latitudes beyond the northern range of the swallow. This may possibly be a mere coincidence, but I think it is not — an opinion strongly supported by another and very broad fact, viz., that in a given district in our own country the gnats become more abundant immediately after the departure of the swallows, martins, etc. If this view is correct, the protection of these birds should be added to the devices named in 'Dragonflies vs. Mosquitoes.'"

— On his return to Germany from Japan sixteen years ago, Professor Rein, the well-known authority on Japanese art and industry, planted in the Botanical Garden at Frankfort some specimens of the lacquer tree (*Rhus vernicifera*), from which the Japanese obtain the juice employed in the production of their famous lacquer work. According to the *London Times*, there are now at Frankfort thirty-four healthy specimens of the lacquer-tree, thirty feet high and two feet in girth a yard from the ground; and the young trees, which have sprung from the original tree's seed, are in a flourishing condition. It seems to be proved, therefore, that the lacquer-tree is capable of being cultivated in Europe, and it only remains to be seen whether the juice is affected by the changed conditions. The *Times* says that, to ascertain this, Professor Rein has tapped the Frankfort trees, and has sent some of the juice to Japan, where it will be used by Japanese artists in lacquer work, who will report on its fitness for lacquering. In the mean time, some of the most eminent German chemists are analyzing samples of the juice taken from the trees at Frankfort, and samples of the juice sent from Japan; and should their reports and the reports from Japan be favorable, it is probable that the tree will be largely planted in public parks and other places in Germany. In course of time a skilled worker in lacquer would be brought over from Japan to teach a selected number of workmen the art of lacquering wood, and in this way it is hoped that a new art and craft may be introduced into Europe.

— The disposal of sewage is a question which has been to the fore for a good many years in various countries, says *Engineering*, but which, perhaps, nowhere on the Continent has been dealt with in a more systematic manner than in Germany. In Berlin the drains from the houses receive both the rain water, the dirty water from the kitchen, etc., and the contents of the water closets, conducting them to a system of radial sewers, through which they, by a natural fall, proceed to a dozen various pumping stations within the area of the town. From these the sewage, through the medium of combined force and suction pumps, passes through pipes of three feet or still greater diameter to the land which the corporation of Berlin possesses, and where the sewage is used as a fertilizer. The sewage makes its final exit through a system of conduits so arranged that before reaching them it has parted with all its manurial power to the soil through which it is made to pass.

The sewage water thus filtered reaches the river through the natural fall of the conduits in a comparatively purified state. The sewage is an exceptionally good manure, and the yield of grass on those fields that receive it is something quite out of the common, so that it can be cut some six or seven times during one summer. This system also seems to answer well so far as the sanitary side of the question is concerned, but still there are a good many places which prefer the method by which the sewage is collected in large tanks, whereby it is possible to benefit larger areas by its fertilizing qualities. Frankfort-on-the-Maine is another German town where the sewerage system is very perfect, but owing to the excessive cost of land in that locality the sewage is not, as in Berlin, used as manure in the first instance. The sewage is purified before being allowed to escape into the Maine, and the residue is pumped into receptacles from where the farmers fetch it. The town of Hanover is also about to adopt the sewerage system on a larger scale. In Augsburg and Heidelberg the barrel system is used, much more satisfactory in the latter than in the former town. In Heidelberg the corporation itself attends to the emptying of the barrels.

— Cloud heights and velocities form the subject of a recent article by Mr. H. H. Clayton in the *American Meteorological Journal*. The paper contains the result of cloud observations made at Mr. A. L. Rotch's observatory at Blue Hill, Mass., during the past five years. The average heights of some of the principal clouds were: Nimbus, 412 metres; cumulus, base, 1,558 metres; false cirrus, 6,500 metres; cirro-stratus, 9,652 metres; cirrus, 10,135 metres. The cumulus is highest at Blue Hill during the middle of the day. The Upsala observations show that the base of the cumulus, as well as the cirrus, increases in height until evening, but neither of these conclusions apply to the observations at Blue Hill. The average velocity found for the cirrus, 82 miles an hour, is twice as great as that found at Upsala. The extreme velocity was found to be 133 miles an hour. A comparison between wind and cloud velocity shows that below 500 metres the wind velocity is less than the cloud velocity. Above that, the excess of the cloud velocity increases up to 1,000 metres, and then decreases again till about 1,700 metres, after which it steadily increases. This decrease between 1,000 metres and 1,700 metres is very probably due to the fact that the clouds between 700 metres and 1,000 metres were mostly observed during the morning, when the cumulus moves most rapidly, and that the clouds between 1,000 metres and 1,700 metres were mostly observed during the afternoon, when the cumulus moves slowest.

— Dr. Borden P. Bowie of Boston University, who has charge of the philosophical department, is now preparing a work on logic. The manuscript is nearly ready for the printers.

— Professor Conn, the head of the biology department of Wesleyan University, Middletown, Conn., has his latest book, "The New World" ready for the press, and it will be issued very soon.

— Professor George S. Bryant of the Alabama Polytechnic Institute has been appointed director of the workshop and assistant professor of mechanical engineering in the Leland Stanford, jun., University.

— Several changes have been made in the faculty of Vassar College, the following new teachers having been added: Professor J. C. Bracq, professor of French; Miss Neef, assistant in French and German; Professor J. L. Moore, professor of Latin; Miss Byrnes, assistant in biological laboratory; Miss Ballantine, director of gymnasium. Mrs. Georgia Kendrick is lady principal.

— Professor George Francis James of the University of Nashville has been appointed lecturer on literature in the University of Pennsylvania and editor of *University Extension*, the official organ of the American Society for the Extension of University Teaching. Mr. James was a student of the Northwestern and Michigan Universities and has done post-graduate work in the University of Halle, Germany, and in the Sorbonne at Paris. Two years ago he gave up the principalship of the Decatur (Ill.) high school to go to Nashville, from which position he has been called to Philadelphia.

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Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

APPLE AND PEAR SCAB.

THE microscope has revealed the fact that the brown scab which has become so prevalent on certain varieties of apples and pears during recent years is itself a plant, reproducing itself by spores, which are borne upon the wind and find their congenial soil in the leaves, tender twigs, and fruit of the apple and pear.

When the nature of the pest was ascertained a remedy was suggested in the treatment which has recently been discovered to be so effective in the case of other fungoid diseases of plants, namely, the spraying of the affected trees with a solution of copper sulphate. This treatment has been recommended by the national Department of Agriculture for several years; but, as heretofore practiced, it has often injured the foliage of the trees to such an extent that the remedy was almost as bad as the disease.

The Ohio Experiment Station has this season conducted an extensive series of experiments, some on its own grounds, some in a large orchard in the neighborhood leased for the purpose, some in the fruit region of the lake shore, and some in orchards along the Ohio River. In these experiments several preventive solutions have been tried, but especial attention has been given to the question whether the strength of the copper sulphate and lime solution (known as the Bordeaux mixture) might not be reduced so as not to injure the foliage and yet accomplish the object of preventing disease. The results of this work were shown in a striking exhibit, made at the State fair and other places, in which sprayed fruit was shown to be almost absolutely free from disease, while that from neighboring trees left unsprayed was almost worthless.

The spraying not only reduces the injury to the fruit, but it largely increases the total crop. This is because the foliage on the sprayed trees remains healthy, while on the unsprayed trees it is diseased and unable to perform its functions. Furthermore, the scabby fruits fail to develop to their normal size, because of the scab that is on them. The sprayed apples are fully twenty-five per cent larger than the unsprayed, and are more highly colored. As might be expected, the sprayed apples sell for more than the unsprayed, there being a difference of more than twenty-five per cent in favor of the former. This was found to be the case by an actual test in the market, the sprayed apples selling more rapidly at fifty cents per bushel than the unsprayed at forty cents. This makes a total gain in favor of spraying of fully fifty per cent. The cost per tree for the season does not exceed twenty-five cents, while there is often a gain of one dollar or more, depending largely upon the variety, as some are much more subject to scab than others. Spraying also prevents the premature falling of the leaves,

which is one of the results of the scab, for it affects the leaf as well as the fruit.

Following are the formulæ used in these experiments: No. 1—copper sulphate, 4 pounds; lime, 4 pounds; water, 1 barrel. No. 2—copper sulphate, 4 pounds; lime, 4 pounds; Paris green, 4 ounces; water, 1 barrel.

No. 1 is used for apple and pear scab, and to prevent the leaves of plum and pear trees from dropping prematurely; also, for raspberry cane scab, or anthracnose. Apply once before the leaves open and about three times thereafter. It should not be used on plums and early fruits later than July 1, and it is not necessary to use it on any fruit later than Aug. 1. It should not be used on raspberries after the blossoms open, and care should be taken to direct the spray to the young growth and avoid the old canes after the first application.

No. 2 is used on pear, apple, plum, and cherry trees after the blossoms fall, for the purpose of destroying insects. On plum and cherry trees the applications should be made once in two weeks, and oftener if the weather is rainy, up to within six weeks of the time of ripening. For the last application on these fruits, it would be well to dilute the mixture one half, or more, so as to avoid lime coating; or the following may be substituted: Paris green, 2 ounces; copper carbonate, 2 ounces; dissolve in three pints of ammonia; add half a pound of lime and one barrel of water.

LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

The Man of the Future.

DOCTOR LANGDON'S remarks in a recent issue of *Science* (No. 452) on the probable further evolution of man is one full of interest to every speculative anthropologist. To the present writer it is evident that man has by no means arrived at the acme of his development, either mentally, morally, or physically; indeed, I conceive the entire genus *homo* to be but little more than just started upon its career of evolutionary growth.

In the first place there are many species and sub-species of men upon the face of the globe of very low type that will either have to be, or will be, exterminated in time by some branch of what ultimately will persist as the dominant race. As examples, we may point to the pygmies of Africa, many of our North American Indians, and similar ferine tribes. Some of these, however, will undoubtedly to a certain extent fuse with the root-stocks of the dominant race; some may be assimilated entirely,—a fate that seems to await the negroes of the United States, and perhaps later the Japanese and others. In short, I am inclined to think that, in the ages to come, the human species of this world will eventually tend to form one homogeneous race, and that race will speak but the one language. When that epoch has fully arrived, then indeed will the human species be fairly on the road towards its perfection. Multifarious tongues now stand as a prime factor in the way of man's more rapid evolution. All this will require an enormous lapse of time, and when it arrives the face of the earth will be greatly changed. Man will have subordinated all things to his will,—and nearly all other forms now existing, with the exception of the very few that may prove useful to man, will have been completely exterminated.

Many of these changes are now slowly advancing under our very eyes. Take the ideal man of the present day,—one of the most perfectly organized ones as they now exist, and what do we find? In the vast majority of cases, as Clevenger has shown, he is still subject to a variety of diseases which arise from the fact that within a comparatively recent time of the world's history he has assumed the erect attitude; has passed from quadrupedal to bipedal locomotion. Often these diseases prove to be fatal,—as prolapsus uteri, the hernias, and others: is there to be no improvement along this line? Again, he has still clinging to his organization many of the structural vestiges that link him with the

brutes: is there to be no improvement in that direction? It has been proven that modifications are taking place in his dental armature, his dermal appendages (as the hair disappearing, and so forth), and perhaps to some extent in his very form, due to dress, as encasing the feet, and strapping certain parts of the body. Will these causes not, if continued, produce their ultimate effects?

However daintily he may mask the animals he kills and devours, he is still as carnivorous as most of the *Felidae*. He often settles his disputes by the murder of masses of his kind, and the leaders in such assaults are glorified by having monuments erected to them in the high places. In these days such monuments are seventy-five per cent more numerous than are those erected to the great among men of letters, of science, the arts, and the industries. All of this savors very strongly of savagery, and can hardly be characteristic of a fully developed race of men.

This aspect is not improved when we come to think of the vast number of what many in the world would reckon as our best developed specimens of men, whose minds are still controlled by the nursery myths, the miracles, and the fables that were told and sung to the children of the early peoples of the world in Asia. Is the mind of the man of the future to remain in such a condition of thralldom? In fact, the most of the opinions held, the institutions, the very language, the entire organization by and of the best existing types of men, are each and all to me highly indicative of a very early stage of the development of the species.

So I cannot fully coincide with Dr. Langdon when he says, "While, therefore, we may anticipate an increase in the average perfection of parts, and consequently a more harmonious development of man's present plan of structure, we cannot rationally look for any radical change in the plan itself." Although it would not demand any radical change in the *plan* of structure of present man, has it ever occurred to your correspondent that in the dim future of the world the *environment* of man may have progressively so changed as ultimately to produce a race of enormous giants; or, other conditions obtaining, a race of the veriest pygmies may be the result? Who among our present-day naturalists, had he lived in Eocene time, and become familiar with the little *Eohippus*, no bigger than a fox, would ever have predicted that from it was in time to be developed the highly modified modern horse? It is safe to say, not one, — yet *Eohippus* must have appeared quite perfect for its kind in its day.

There is every reason to believe that in the lapse of time, or when many more millions of years have rolled by, our little earth will become cold from changes now going on: she may solidify to her very core, and become as frigid as a moon, and utterly incapable of supporting any manner of life upon her surface. In fact, life will probably be at an end long before any such condition in her comes about. The last one of the human species, the very last individual of all, the very tip of the last twig of the tree of human descendants, must also die, — perish. If that modified form possesses sight, its eye may look out upon a remarkable scene indeed. Earth may be stripped of all timber; coal beds all burned up; metals all moulded into medallions, machines, and monuments; her land-surface graded nearly or quite level by causes now in operation; every other living thing, every lion, lark, and louse in the land exterminated; and nothing remaining but the works of the modified man. R. W. SHUFELDT, M.D.

Takoma, D.C., Oct. 9.

Rain-Making.

IN *Science* for Oct. 9 Mr. Powers takes exception to a short discussion of this question prepared by myself and published in August. I have no desire to enter the discussion, but simply to correct one or two misapprehensions of my own connection with this matter. Mr. Powers gives a novel view of Plutarch's statement regarding battles and rain. The following is a translation of Plutarch: "Extraordinary rains generally fall after great battles." He is doubtful whether by these the gods would wash out the trouble from the sky "or the blood and corruption, by the moist and heavy vapors they emit, thicken the air, which is liable to be altered by the smallest cause." It hardly seems as though this corresponds with the later view of Mr. Powers. But the view

of another rain-maker does not agree with that of Mr. Powers: "Let 10,000 Greeks march into battle chanting their 'paean' and shouting their 'allallas,' beating time meanwhile on their shields, while 100,000 Persians are advancing against them, continually shouting their terrible battle-cries; then let the great armies rush together with the tumult of clashing swords and shields, the hoarse death-cries and shouts of victory, and surely the sound-waves rising from such a din will literally shake the heavens, and are capable of producing no insignificant effect among the volatile currents of the upper air. Moreover, the heat generated from the struggling masses and the moisture evaporated from their perspiration would exercise a decided influence in disturbing the equilibrium of the atmospheric conditions."

Exception is taken to my very guarded statement, "During the war of the Rebellion there were over 2,200 battles, on an average *probably* as severe as the average of the 158 above mentioned" (by Mr. Powers). I have italicized a very important word. I had no time to do anything more that compare several of the running statements of the battles given in the old edition of "War and the Weather" with other facts. This I did sufficiently to satisfy myself that such a statement could be made. It is an open question in my mind just how one should treat a continued battle and firing in studying its probable effect upon the atmosphere. The more or less desultory firing in many battles could not be considered as of much importance. Moreover, any rain which fell after an interval of a few minutes must probably be regarded as in no wise due to the explosions. I do not say that the smoke and carbon from the powder might not have some influence, but whatever they had would be felt a hundred miles or more from the scene of the explosions.

Mr. Powers thinks that the currents of the atmosphere do not travel at the rate of twenty to fifty miles per hour, or, at least, during these battles they did not do so. This is a question of fact which has been proved by actual observation, and cannot be gainsaid. The only time these currents are not moving with this velocity is when a high area or "clearing condition" is passing. Mr. Powers's theory of storm formation is exceedingly unique, and possibly he could help meteorology by establishing that theory. What he would need to do would be to select a high area or a "clearing condition," and then make his explosions and note the result. It certainly is not a fact that two currents pass in opposite directions near the point of formation of our storms. Mr. Powers takes exception to my statement, "One thing seems very evident, that absolutely no rain can be obtained out of a dry atmosphere." I will now take out the word "seems" which has no business in this statement, and leave the rest without fear of contradiction by any one who reads the expression as I meant it.

H. A. HAZEN.

Washington, D.C., Oct. 12.

BOOK-REVIEWS.

Laboratory Practice. By JOSIAH PARSONS COOKE, LL.D. New York, Appleton. 16°. \$1.

ALL students of chemistry are familiar with "The New Chemistry," by Professor Cooke, the first edition of which appeared eighteen years ago, when it was one of the earlier volumes of the International Scientific Series. That book, which has fascinated so many, now appears in a revised and enlarged form. The book now issued is described by the author as a "companion volume to 'The New Chemistry.'" As will be remembered, the earlier book was largely descriptive of the problems and theoretical discussions of modern chemistry. "Laboratory Practice" gives a series of experiments on the fundamental principles of chemistry. The purpose of the author is to furnish the beginner in chemistry with a text-book which shall aid him in doing his laboratory work, but only when this work is carried out under the guidance of a competent teacher, — a teacher who can speak to the students from the fulness of his own knowledge. Professor Cooke, as the head of the chemical department of Harvard College almost as long as there has been such a department — for more than forty years — has had great experience as a teacher of chemistry, and it is certain that each and all of those who have had the pleasure of tak-

ing courses under him can testify that he could always speak from the fulness of his knowledge. It has seemed in perusing this new book that the author did not always appreciate that others had not equal experience, and to those who find descriptions of apparatus difficult to follow without the aid of illustrations, their almost total absence may be disappointing. But it is enough to say that Professor Cooke has brought out this new book to make sure that all teachers of chemistry will be anxious to examine it.

Eighty-odd experiments are described, some of them, owing to the modern developments, of a physical rather than of a chemical nature as formerly understood. The apparatus called for is not expensive, and can be rendered even less so by resort to various make-shifts, which are, however, always bothersome and time-consuming.

Conduct as a Fine Art. The Laws of Daily Conduct, by NICHOLAS P. TILMAN; *Character Building*, by EDWARD P. JACKSON. New York, Houghton, Mifflin & Co. 12°. \$1.50.

SOME time since the American Secular Union of Philadelphia offered a prize of one thousand dollars for the best treatise for teaching morals in the public schools without inculcating any religious doctrine, and the prize was divided between the authors of the two works here named. They are quite different in literary form, Mr. Gilman's being an essay in several chapters, and Mr. Jackson's a series of conversations between a teacher and his pupils. Religion as a basis of morality having been set aside, it is held to be necessary to give it a "scientific basis;" and Mr. Gilman in particular makes special claims for his work on this account. After a careful reading of it, however, we are unable to find any scientific quality in it. The only way to make ethics scientific is to find the ultimate ground or criterion of right and wrong, and then deduce all minor principles from this fundamental one. But Mr. Gilman expressly repudiates any design of doing so, apparently because he has no settled opinion as to what the criterion is. Nor is there anything scientific in the arrangement of his work; on the contrary, it is a series of desultory chapters which might just as well have been arranged in any other way. Mr. Jackson makes much less pretension of being scientific; but after reading both works we can readily understand the statement in the preface that the society that offered the prize was not satisfied with either of them.

But in saying these things we do not wish to be understood as condemning the essays, either of them. They present the common-sense ethics of the time in a form suitable for instructing children, and in the hands of good teachers may be made useful. They are intended rather for teachers than for pupils, it being supposed that the teacher will instruct his pupils orally; and teachers of strong moral instincts who are also good talkers would probably teach best in that way. To such teachers this book will undoubtedly furnish many valuable hints.

A Hand-book of Industrial Organic Chemistry. By SAMUEL P. SADTLER, Ph.D. Philadelphia, Lippincott. 8°. \$5.

WAGNER'S "Chemical Technology," which is about the only book of moderate size in English which describes the chemistry of industrial processes, is now somewhat antiquated, though doubtless some day a new edition will appear. There are the encyclopedias of chemistry and of chemical industries, but no single volume.

Dr. Sadtler has endeavored, within the compass of a moderate-sized octavo, to take up a number of the more important chemical industries, or groups of related industries, and to show in language capable of being understood, even by those not specially trained in chemistry, the existing conditions of those industries. The present volume is limited to industrial organic chemistry. This field, while covering many very important lines of manufacture, does not seem at present to be so well provided for as the inorganic part of the subject. A companion volume, covering this other side of industrial chemistry, is in contemplation.

In taking up the several industries for survey, there are first enumerated and described the raw materials which serve as the basis of the industrial treatment; second, the processes of manufacture are given in outline and explained; third, the products, both in-

termediate and final, as well as side-products, are characterized and their composition illustrated in many cases by tables of analyses; fourth, the most important analytical tests and methods are given which seem to be of value either in the control of the processes of manufacture or in determining the purity of the product and, fifth, the bibliography and statistics of each industry are given, so that an idea of the present development and relative importance of the industry may be had.

The author has endeavored in a number of cases to give a clearer picture of the lines of treatment for an industry by the introduction of schematic views of the several processes through which the raw material is carried until it is brought out as a finished product.

The subjects treated are: petroleum and mineral oil industry; industry of the fats and fatty oils; industry of the essential oils and resins; the cane-sugar industry; the industries of starch and its alteration products; fermentation industries; milk industries; vegetable textile fibres; textile fibres of animal origin; animal tissues and their products; industries based upon destructive distillation; the artificial coloring matters; natural dye-colors; bleaching, dyeing, and textile printing.

That such a book is needed cannot be questioned. It will be of value to the specialists engaged in industrial chemistry and to the general reader seeking information.

The author has had experience in writing chemical books and in editorial work. The number of illustrations is large, and they are well made and increase materially the value of the book for the purposes for which it is intended. There is also a considerable number of valuable tables.

A Study of Greek Philosophy. By ELLEN M. MITCHELL. Chicago, S. C. Griggs & Co. 12°. \$1.25.

THE authoress of this book has been for some years the leader of a band of ladies who have devoted themselves to the study of philosophy. Being a disciple of Hegel, it was natural that she should devote special attention to the history of philosophy, that aspect of the subject having been given special prominence by Hegel himself and by some of his principal followers; and this sketch of the Greek philosophy is the outcome of her studies. It is written in an earnest and serious spirit, and with an evident desire to present the truth as the writer understands it. It is impartial, too, as between the different schools and thinkers, none of them being slighted and no decided preference shown for one over another except as their real importance demands it. The chief fault of the book, to our thinking, is its excessive Hegelianism. In treating the various Greek thinkers, those points in their teaching that seem to anticipate Hegel's philosophy, or lend it support, are given special prominence, and sometimes there is a tendency to read into the ancient writers views derived from Hegel himself. Then the frequent repetition of the Hegelian catchwords, such as "self-consciousness," "the idea," "subjectivity and objectivity," the "infinity of mind," etc., detracts from the merit of the work.

Miss Mitchell has followed Zeller largely in her interpretation of the Greek thinkers, but has also derived something from Hegel's history of philosophy, and she quotes occasionally from both these writers. Her account of the earlier philosophers is one of the best parts of her work, their leading characteristics, as far as known, being very clearly presented in a small space. In the chapters relating to Plato and Aristotle the dialectics and physics of these writers are examined at greater length than seems necessary; while in the latter part of the book we could have wished for a little more information about the relations between Greek philosophy and Jewish and Christian thought. But though the book is not free from faults, it has much to recommend it, and it will be specially acceptable to adherents of German philosophy.

The Philosophy of the Beautiful. I. Its History. By WILLIAM KNIGHT. New York, Scribner. 16°. \$1.

THIS book is one of a series to be published by John Murray in England and by Messrs. Scribner in America, and designed to furnish books for study and reference on a variety of subjects. They bear the general title of "University Extension Manuals,"

and, if we may judge from the names of the books and authors given in the prospectus, are likely to be of real value. The volume before us is by the editor of the series, and is devoted to a history of esthetics from the days of the Greek philosophers to the present time. Another volume is projected by the author, in which he will discuss the subjects of beauty and art themselves, and will present a constructive theory of his own. The present work is a succinct but useful summary of the teachings of previous writers, presented with impartiality and in a clear and attractive style. The ancient writers are first treated of, Plato and Aristotle occupying the foremost places; and then, after a brief glance at certain mediæval philosophers, the esthetic writers of modern times are taken up, those of each nation being grouped together. Thus the philosophy of Germany from the earliest times to the present is first dealt with, then those of France, Italy, Holland, Britain, and America. This arrangement enables us to see the effect of national genius on the philosophy and criticism of art, but fails to show with equal clearness what the writers of one nation have owed to those of another. The principal fault of Professor Knight's work, as it seems to us, is the attention given to insignificant authors, who contributed nothing to the subject, either by philosophy or by criticism, and who might better have been passed over in silence. The impression produced on the mind by the book is in one respect discouraging, for it seems to show that little real advance in the philosophy of beauty has been made since ancient days. The theory, first promulgated by Plato and afterwards adopted by Aristotle, that the essence of beauty consists in harmony and proportion, still holds its ground; but the dispute between Aristotelian realism and Platonic idealism is as unsettled as ever. We commend Professor Knight's book to students of esthetics, and shall look with interest for his second volume.

Electricity and Magnetism. Translated from the French of AMEDEE GUILLEMIN. Revised and edited by Silvanus P. Thompson. London and New York, Macmillan. 8°. \$8.

THIS is certainly as fine a piece of book making in the line of the physical sciences as we remember having seen for some time. A few French writers have in the past brought out these handsome volumes in popular exposition of this or that branch of science, and occasionally these have been translated. But there have been few published in English except as translations.

That Professor Silvanus P. Thompson is known as the writer of good books in electrical science goes without saying, and his standing as a physicist is unquestioned, as has been recognized by his election not many years ago as a Fellow of the Royal Society. The editor, however, claims responsibility on but a few points. The chapters on dynamo-electric machines and on the telephone were largely rewritten by him, and brought into accordance with modern knowledge; and throughout the book frequent editorial notes in brackets are inserted that bring the statements up to date.

The book is not intended for the student, but as a popular, simple, non-mathematical exposition of the science which now attracts such general interest. The volume is certainly one on which a great amount of labor and money must have been expended, but there has been left in a great deal of matter of purely historical interest, matter not of a character likely to please any one looking only for the latest information. Electrical science has moved considerably in the past ten years, and it has been difficult for the editor to conceal the evident influence of the Pan-Electrical Exposition of 1881 as a recent event on the French original.

When one is asked for a popular book on electricity and magnetism, the answer is a difficult one, since such valuable manuals as the "Principles of Electricity and Magnetism," by Professor Thompson, may prove too formally scientific for the untrained reader. There is certainly no other work in English that treats electricity and magnetism in so untechnical a way as does this by Guillemin; we only question whether it might not have been of half the size and served its purpose as well. The first part of the volume is devoted to the pure science, the second to the applications in the industries.

AMONG THE PUBLISHERS.

F. A. BROCKHAUS, Leipzig, announces a new edition (the fourteenth) of his "Brockhaus' Konversation-Lexikon." The first volume of the first edition was published in 1796, so that the present is projected as a sort of century-jubilee edition. The work will be very much enlarged and printed in a sumptuous manner. It may be had in 256 weekly parts or in sixteen bound volumes.

— Messrs. D. Appleton & Co. are about to publish "Freeland: A Social Anticipation," by Dr. Theodor Hertzka, a book which has been called the German "Looking Backward." This work describes an imaginary colony in equatorial Africa, in which Dr. Hertzka's economic system of land and capital nationalization, combined with absolutely untrammelled industrial competition, is carried out. The book has given rise already to local societies in Vienna, Buda Pest, Prague, Czerarowitz, Berlin, Hamburg, Brunswick, Hanover, and some fourteen other places, which will ultimately be united into an International Free Society for the purpose of establishing such a colony as is described in the book.

— *Babyhood* contains the following among other articles in its October issue: "The Management and Care of Near-Sighted Eyes," by J. M. Mills, M.D.; "The Airing and Exercise of Infants," by Alfred Stengel, M.D.; "The Bones in Childhood," by Harriet Brooke Smith, M.D.; "Nursery Ventilation;" "The Nursery Chair;" "Sweets;" "From One to Five;" "How to Carry the Baby;" "Neglect of Milk Crust;" "Fat Babies vs. Lean Babies;" "Blowing Baby's Nose;" "A Night Jacket;" "Washing Baby's Flannels;" "Contagion from Whooping Cough;" "Buying a Cow for the Baby;" "Condensed Milk for a Long Journey;" "Quantity of Food at One Year;" "Hard and Soft Water as Affecting Teeth;" "A Cure for the Green Apple Habit."

— "Seas and Lands" is the title Sir Edwin Arnold has given to the account of his recent travels, which the Longmans will publish at once. The earlier chapters are devoted to Canada and the United States, but the bulk of the book is given up to Japan as it impressed the author of the "Light of Asia" day by day. There are more than forty full page illustrations from photographs. The same firm will issue at once Canon Farrar's new copyright novel, "Darkness and Dawn; or, Scenes in the Days of Nero." This historic tale is the author's first venture into fiction for many years, and it is the result of his investigation into the early history of Christianity. He has stuck more closely to the facts than most writers of fiction, and he declares that the "outline of his story is determined by the actual events of pagan and Christian history."

— In the *Magazine of American History* for October an article by the editor, "A Group of Columbus Portraits," deals with facts and picture-pedigrees, giving fac-similes of the oldest and rarest engraved prints of Columbus portraiture extant, with much other data of timely consequence. The double-headed contemporary print of the portraits of Ferdinand and Isabella is included; and Mrs. Lamb adds to her essay suggestive sketches of those sovereigns and their great military triumphs in connection with Columbus and the dawn of America upon the map of the world. W. F. Ganong follows with a paper on "The St. Croix of the Northeastern Boundary," and four illustrative maps. "Hugh McCulloch on Daniel Webster" is an excerpt of interest. The longest article in the number is a study by Right Reverend M. F. Howley, D.D., P.A., of Newfoundland, on "Cabot's Landfall," the scene of which he traces, according to his judgment, in an elaborate accompanying map. Then comes a contribution pertinent to the approaching World's Fair, "The Sultan of Turkey and the Chicago Exhibition," by Frederick Diodati Thompson, touching on the calamities and historic growth of Chicago, and presenting many facts about Turkey and its ruler, whose visit to America on the opening of the Columbian exposition is foreshadowed. Other articles include "Philadelphia in 1778 through Foreign Eyes," and "Napoleon Bonaparte and Peace with America."

— Dr. De Kroustekoff, an eminent chemist and mineralogist of St. Petersburg, recently paid a visit of some weeks to the United States, charged with a scientific mission by the Russian Govern-

ment. Dr. de Kroustokoff announces a series of translations in Russian from the works of leading American, French, and German scientists. The first of these volumes, it is expected, will appear next year, and is to comprise the greater part of Dr. T. Sterry Hunt's "New Basis for Chemistry," together with his studies of the origin and succession of crystalline rocks, the crenitic hypothesis, and various related subjects.

— Messrs. Macmillan & Co. will publish next month a "Browning Cyclopædia," by Dr. Edward Berdoe, one of the most active members of the Browning Society. This volume will deal with the whole of the poet's works, and will contain a commentary on every poem, with explanations of all obscurities and difficulties arising from the historical allusions, legends, classical and archaic phraseology, and curious out-of-the-way terminology, which makes Browning so difficult for the ordinary reader.

— Professor J. R. Cooke of Harvard University, author of the well-known "New Chemistry" in the International Scientific Series, has written a most helpful new book entitled "Laboratory Practice," which, as its name indicates, will be a practical aid to students. The book is designed for a companion to Professor Cooke's "The New Chemistry," which has been for many years a standard work, and has been translated into all the principal European languages. The new book is brought out by the publishers of the other, D. Appleton & Co.

— In addition to the fall announcements of Macmillan & Co. made in our issue of Sept. 25, we note the following. "Symbolism in Christian Art," and "Heraldry," by F. E. Hulme; "Monumental Brasses," by the Rev. H. W. Macklin; Behaghel's "The German Language," translated and adapted for the use of English schools by Emil Trechmann; "A History of Early English Literature," by the Rev. Stopford A. Brooke; "The Buccaneers of America," by Captain James Burney (reprinted from the edition of 1816); "Some Aspects of the Greek Genius," by S. H. Butcher, professor of Greek, Edinburgh; "The Inferno of Dante," translated, with a commentary, by A. J. Butler; "English Literature at the Universities," by S. Churton Collins; "Browning's Message to His Time," by Dr. Edward Berdoe (with a portrait and facsimile letters; second edition, revised and enlarged); "Dante and His Ideal," by Herbert Baynes (with a portrait); "Goethe," by Oscar Browning (with a portrait); "Dante," by Oscar Browning (with portrait); "Browning's Criticism of Life," by W. F. Revell; "Henrik Ibsen," by the Rev. Philip H. Wicksteed; "Epictetus (the Discourses of)," with the Eucheiridion and Fragments reprinted from the translation of George Long (printed on hand-made paper, bound in buckram); "Battles, Bivouacs and Barracks," by Archibald Forbes; two new volumes of essays by E. A. Freeman (I. — Historical, II. — Miscellaneous); "A Short Manual of Philology for Classical Students," by P. Giles, fellow of Gonville and Caius College, Cambridge (uniform with Dr. Gow's "Com-

Publications received at Editor's Office,
Oct. 7-13.

- BRAINARD, F. R. The Sextant and other Reflecting Mathematical Instruments. New York, Van Nostrand. 120 p. 16°. 50 cents.
CANADA, Annual Report of the Geological and Natural History Survey of, 1888-89. Vol. IV. Montreal, Government. 4°. \$2.
COOKE, J. P. Laboratory Practice. New York, Appleton. 192 p. 12°. \$1.
GUILLEMIN, A. Electricity and Magnetism (rev. and ed. by S. P. Thompson). London and New York, Macmillan. 976 p. 4°. \$8.
KNIGHT, W. The Philosophy of the Beautiful. New York, Scribner. 288 p. 12°. \$1.
MITCHELL, E. A Study of Greek Philosophy. Chicago, Griggs. 282 p. 12°. \$1.25.
PLYMPTON, G. W. How to Become an Engineer. New York, Van Nostrand. 218 p. 16°. 50 cents.
STODDARD, C. A. Across Russia. New York, Scribner. 253 p. 8°. \$1.50.
UNITED STATES and the Dominion of Canada, Normal Temperature Charts by Decades for the Washington, Government. 72 p. 1°.

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